Appendix 3-7

Sample Adequacy

SAMPLE ADEQUACY

When assessing vegetation community parameters, the sample taken should adequately represent the entire community. CAIN (1938) proposes that the minimal sample area adequate for assessing the species composition of a community was that area at which a 10% increase in sample area netted a 10% increase in the number of species. A more conservative minimal area is that where a 10% increase in sample area nets a 5% increase in the number of species. MUELLER-DOMBOIS and ELLENBERG (1974) advise that the minimum area sampled should always be larger than CAIN's minimal area.

RICE and KELTIN (1955) advise that when sampling for cover and productivity, the sum of the areas of the quadrats sampled should equal or exceed the minimal area for composition.

Table 1 below lists the 10% and 5% minimal areas for the several communities that will be disturbed by mining and construction activities in the Genwal Permit area. In addition, the actual areas sampled are listed.

SAMPLE ADEQUACY TABLE 1

Community	Minimal Areas 10%	Minimal Areas 5%	Area Sampled
Mountain Shrub/Grassland	$10m^2$	$16m^2$	$30m^2$
Mixed Mountain Shrub/Conifer/Aspen	$10m^2$	$21m^2$	$30m^2$
Spruce/Fir/Aspen	$13m^2$	$18m^2$	$30m^2$
Riparian	$6m^2$	$17m^2$	$22m^2$
Previously Disturbed	$10m^2$	$14m^2$	$30m^2$

For determing cover and productivity sample adequacy COOK and BONHAM (1977) formulate a statistical test for determinng the minimum number of samples required to achieve a desired level of confidence to detect a certain percentage change in the population mean.

$$n_{min} = \frac{t^2 2s^2}{(\bar{x}c)^2}$$

where n_{min} = minimum number of samples required

$\bar{x}$ = sample mean

s = standard deviation of the sample

t = two-tailed value from t table for a given probability, with appropriate degrees of freedom

c = percent change to be detected

In Table 2 below are listed the level of confidence achieved by the sample taken in the five vegetation communities to be disturbed. In Table 3 is listed the number of samples needed to achieve a 90% probability of detecting a 10% change in the population mean of the five communities in question.

SAMPLE ADEQUACY TABLE 2

Community	Sample Size	# Samples Taken	# Samples Needed-Cover	# Samples Needed-Productivity	% Confidence Level	% Change Detect
1. Previously disturbed	$1m^2$	30	28		90	30
	$1m^2$	30	24	29	80	25
2. Mtn. Shrub/Grassland	$1m^2$	30	29		80	25
	$1m^2$	30		30	80	40
3. Mixed Mtn. Shrub/ Conifer/Aspen	$1m^2$	30	29		80	25
	$1m^2$	30		28	80	40
4. Spruce/Fir/Aspen	$1m^2$	30	24	26	90	30
	$1m^2$	30	20	22	80	25
5. Riparian	$0.2m^2$	109	90		90	20
	$0.2m^2$	109		110	90	30
	$0.2m^2$	109		96	80	25

SAMPLE ADEQUACY TABLE 3

To achieve 90% probability of detecting 10% change in population mean.

Community	# Samples Needed - Cover	# Samples Needed - Productivity
1. Previously disturbed	247	305
2. Mtn. Shrub/Grassland	305	806
3. Mixed Mtn. Shrub/Conifer/Aspen	332	750
4. Spruce/Fir/Aspen	213	236
5. Riparian	360	991

A statistical test for determining the minimum number of samples required for determining tree density has been formulated by the Wyoming Department of Environmental Quality.

$$n_{min} = \frac{2(sz)^2}{(\bar{x}d)^2}$$

where n = minimum number of samples required

$\bar{x}$ = sample mean

s = standard deviation of sample

z = the z statistic from z table

d = % change to be detected

Table 4 below lists the levels of confidence achieved for the samples taken in the three applicable areas to be disturbed.

SAMPLE ADEQUACY TABLE 4

Community	# Samples Taken	# Samples Needed	% Confidence Level	% Change Detected
1. Mtn Shrub/Grassland	20	14	90	10
2. Mixed Mtn Shrub/Conifer/ Aspen	20	16	90	20
3. Spruce/Fir/Aspen	20	19	90	12

References

CAIN, S.A. 1938 The Species-area curve. Am. Midland Naturalist 19:573-581

COOK, C.W. and C.D. BONHAM, 1977. Techniques for Vegetation Measurements and Analysis for a Pre- and Post-mining Inventory. Colorado State University Range Science Dept. Science Series # 28.

MUELLER-DOMBOIS, D. and H. ELLENBERG, 1974 Aims and Methods of Vegetation Ecology. John Wiley and Sons, Inc., New York 547 p.

RICE, E.L., and R.W. KELTING, 1955, The species-area curve. Ecology 36:7-11.

Wyoming, Department of Environmental Quality, Guideline No. 2, revised March 1978.

SAMPLE ADEQUACY, TABLE 2 REVISED

Community	n	df	$\bar{x}$	s	t(∞)	n(min)	t(df)	n(min)
1. Previously Disturbed								
a. % Cover	3	2	50.70	5 2	1.28	0.50	1.886	1.09
b. Productivity (g/m^2)	3	2	110.77	31.65	1.28	3.34	1.886	7.26
2. Mtn. Shrub/Grassland								
a. % Cover	3	2	23.27	7.51	1.28	4.27	1.886	9.26
b. Productivity (g/m^2)	3	2	64.27	27.75	1.28	7.64	1.886	16.58
c. Tree density (meters)	20	19	4.31	1.01	1.28	2.25	1.328	2.42
3. Mixed Mtn. Shrub/Conifer/Aspen								
a. % Cover	3	2	36.27	4.35	1.28	0.59	1.886	1.28
b. Productivity (g/m^2)	3	2	25.43	7.30	1.28	3.38	1.886	7.33
c. Tree density (meters)	20	19	4.17	1.86	1.28	8.15	1.328	8.77
4. Spruce/Fir/Aspen								
a. % Cover	3	2	46.93	12.67	1.28	2.99	1.886	6.48
b. Productivity (g/m^2)	3	2	62.90	18.80	1.28	3.66	1.886	7.94
c. Tree density (meters)	20	19	3.02	0.88	1.28	3.48	1.328	3.74
5. Riparian								
a. % Cover	10	9	47.11	19.05	1.28	6.70	1.383	7.92
b. Productivity (g/m^2)	10	9	20.17	10.19	1.28	10.45	1.383	12.20
6. Vegetation Reference Area								
a. % Cover	3	2	23.90	4.04	1.28	1.17	1.886	2.54
b. % Cover	4	3	20.03	8.42	1.28	7.24	1.638	11.85
c. Tree density (meters)	25	24	5.08	1.70	1.28	4.59	1.318	4.86